<Division of Environmental Chemistry>Hydrospheric Environment Analytical Chemistry

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– Hydrospheric Environment Analytical Chemistry –

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Scope of Research

(i) Biogeochemistry of trace elements in the hydrosphere: Novel analytical methods are developed for trace metals and its isotopes. Distribution of trace elements in the hydrosphere and its effects on ecosystem are investigated. The study also covers hydrothermal activity, deep biosphere and paleocean.
(ii) Ion recognition: Novel ligands and ion recognition system are designed, synthesized and characterized.

KEYWORDS

Analytical Chemistry
Marine Chemistry
Trace Elements
Stable Isotopes
Metal Ion Recognition

Selected Publications

Takano, S.; Tanimizu, M.; Hirata, T.; Sohrin, Y., Determination of Isotopic Composition of Dissolved Copper in Seawater by Multi-Collector Inductively Coupled Plasma Mass Spectrometry after Pre-concentration Using an Ethylenediaminetriacetic Acid Chelating Resin, *Anal. Chim. Acta*, **784,** 33-41 (2013).
Tanimizu, M.; Sohrin, Y.; Hirata, T., Heavy Element Stable Isotope Ratios: Analytical Approaches and Applications, *Anal. Bioanal. Chem.*, **405,** 2771-2783 (2013).
Vu, H. T. D.; Sohrin, Y., Diverse Stoichiometry of Dissolved Trace Metals in the Indian Ocean, *Scientific Reports*, **3,** DOI: 10.1038/srep01745 (2013).

Determination of Isotopic Composition of Copper in Seawater

Copper is an essential trace metal that shows a vertical recycled-scavenged profile in the ocean. To help elucidate the biogeochemical cycling of Cu in the present and past oceans, it is important to determine the distribution of Cu isotopes in seawater. However, precise isotopic analysis of Cu has been impaired by the low concentrations of Cu as well as co-existing elements that interfere with measurements by multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS). The objective of this study is to develop a simple Cu pre-concentration method using Nobias-chelate PA1 resin (Hitachi High Technologies). This extraction followed by anion exchange, allows precise analysis of the Cu isotopic composition in seawater. Using this method, Cu was quantitatively concentrated from seawater and >99.9999% of the alkali and alkaline earth metals were removed. The technique has a low procedural blank of 0.70 ng for Cu for a 2 L sample and the precision of the Cu isotopic analysis was ±0.07‰ (±2SD, $n = 6$). We applied this method to seawater reference materials (i.e., CASS-5 and NASS-6) and seawater samples obtained from the northwestern Pacific Ocean. The range of dissolved δ^{65}Cu was 0.40–0.68‰.

Figure 1. Mr. Shotaro Takano working on the R/V Hakuho Maru, who is the primary researcher of this study.

Diverse Stoichiometry of Dissolved Trace Metals in the Indian Ocean

Trace metals in seawater are essential to organisms and important as tracers of various processes in the ocean. However, we do not have a good understanding of the global distribution and cycling of trace metals, especially in the Indian Ocean. We report the first simultaneous, full-depth, and basin-scale section-distribution of dissolved (D) Al, Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb in the Indian Ocean. The samples were collected during the GEOTRACES JAPAN KH-09-5 cruise of R/V Hakuho Maru in the Indian Ocean from November 2009 to January 2010 in the northeast monsoon season. Our data reveal widespread co-limitation for phytoplankton production by DFe and occurrence of redox-related processes. The stoichiometry of the DM/phosphorus ratio agrees within a factor of 5 between deep waters in the Indian and Pacific, whereas it shows variability up to a factor of 300 among water masses within the Indian Ocean. This indicates that a consistent mechanism controls the stoichiometry in the deep waters, which are significantly depleted in Mn, Fe, and Co compared to requirements for phytoplankton.

Figure 2. Group photograph of the captain and on-board researchers and students of KH-09-5 cruise at Cape Town harbor.